

Interface between TBM and Lining

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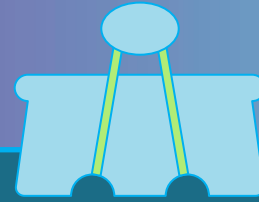
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AECOM

Interface between TBM and Lining



Agenda

Introduction

Lining diameter

Segment arrangement and geometry

Segment thickness / height

Segment width & key

Division of segment ring

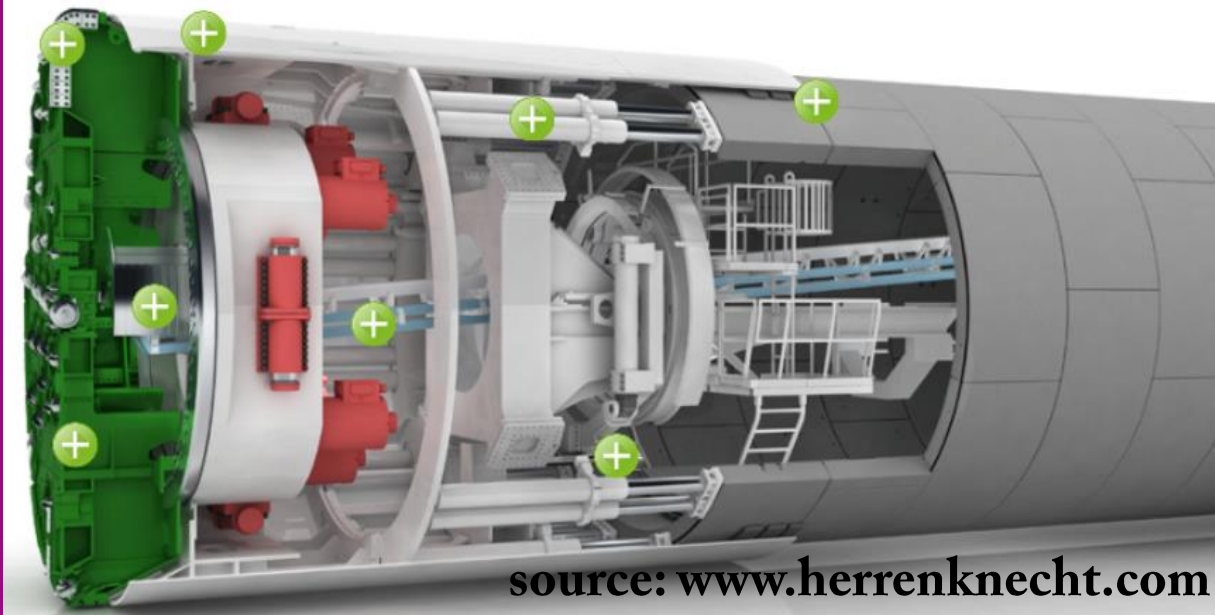
Segment weight

Q & A



Interface between TBM and Lining

Introduction



The construction of a tunnel with shielded Tunnel boring machine requires the realization of the a concrete lining(segment lining) in the tail of the machine at a certain distance from the excavation face

Interface between TBM and Lining

EXCAVATION & FACE SUPPORT

TBM
operating
principle at a
glance



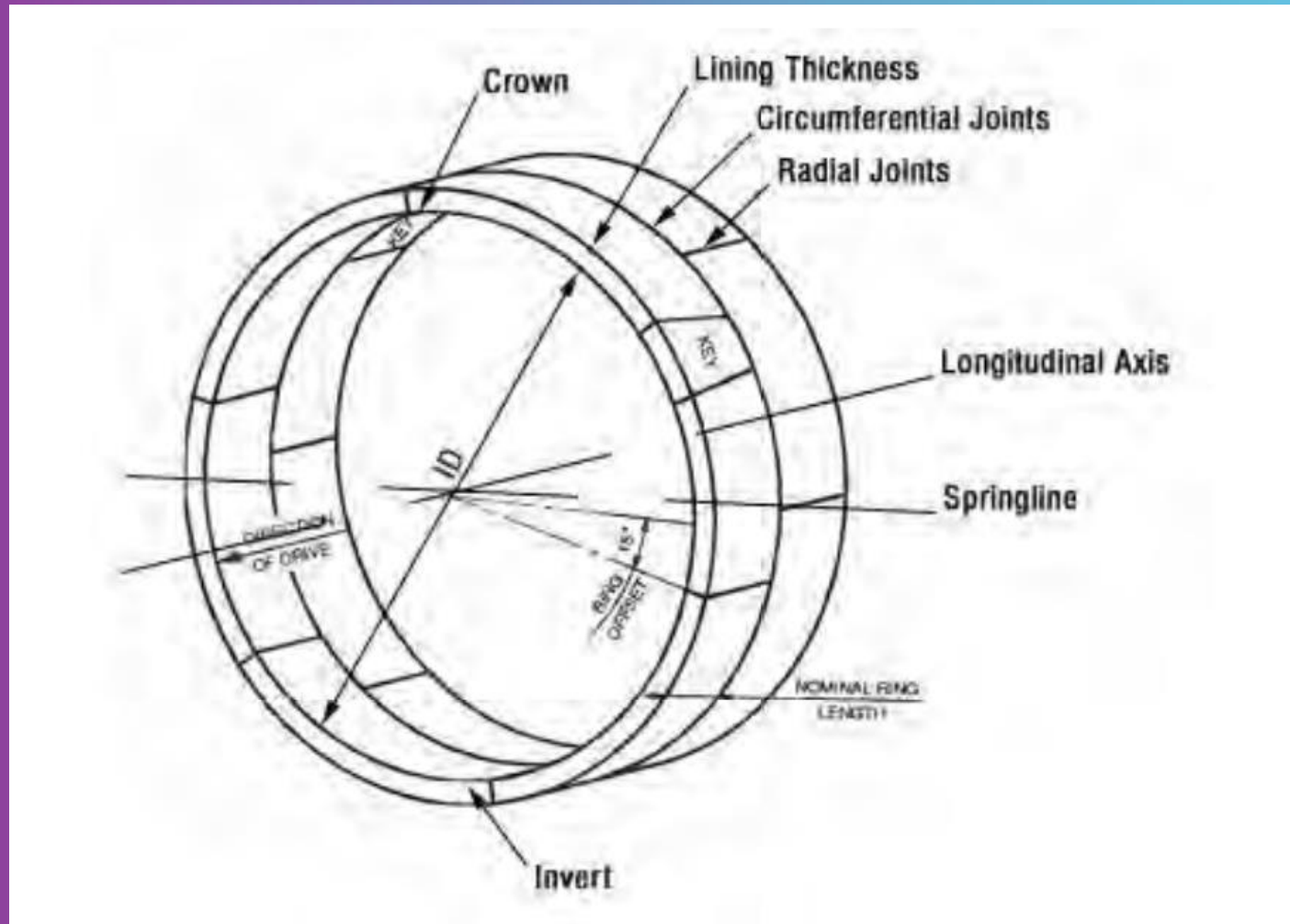
TUNNEL LINING

Interface between TBM and Lining

- Most of the time the parties involved in dealing the TBM and Segmental lining are different i.e The TBM is manufactured by one party and the Segment linings are manufactured by a different party .

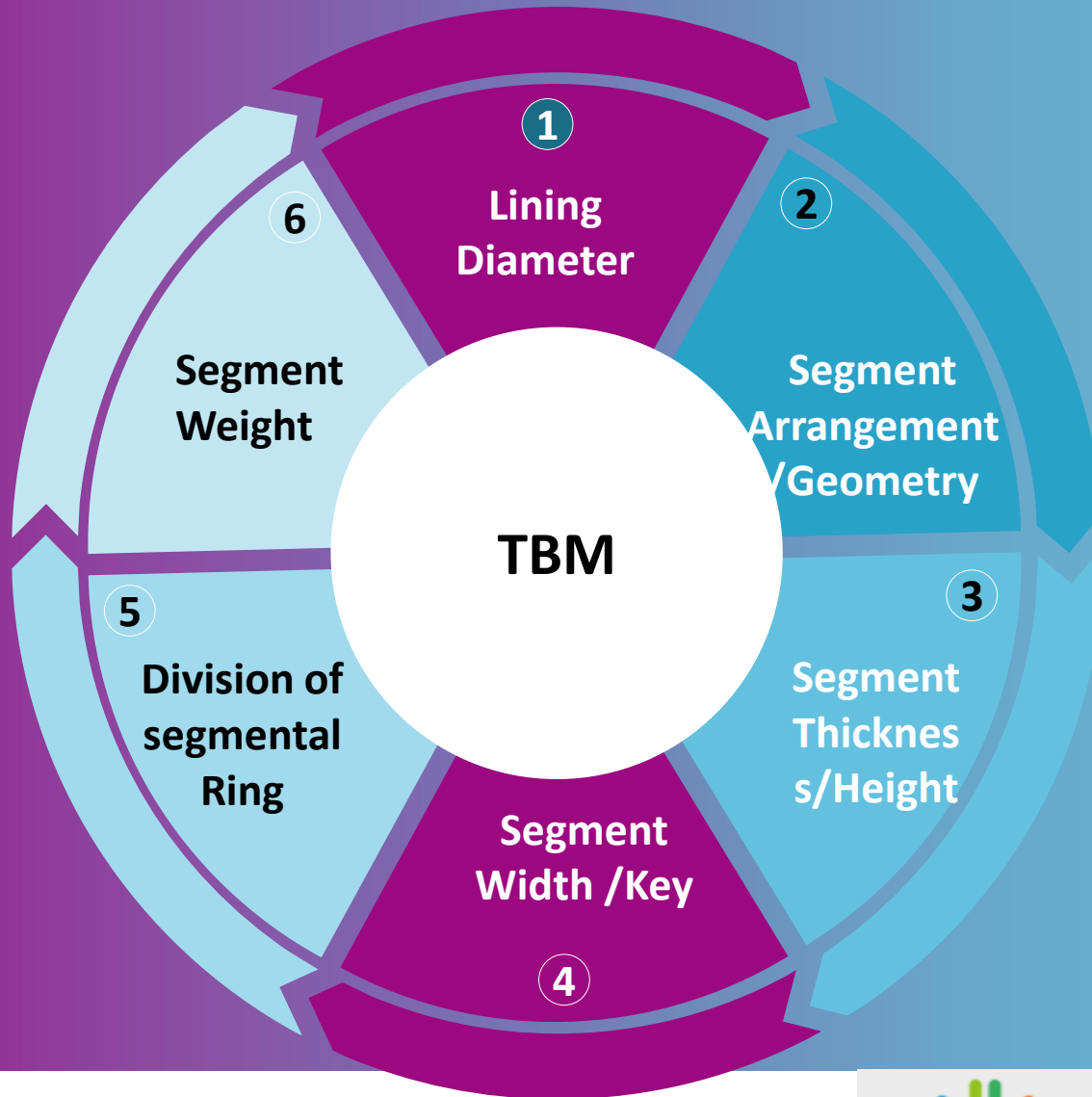
Interface between TBM and Lining

Terminology
and
Geometry as
per ITA -AITES



Interface between TBM and Lining

The success of a tunnel project relies on many factors, but one of the most important factors is the integration of the Machine and the Segmental Lining.



Interface between TBM and Lining

Lining diameter

Interface between TBM and Lining

TBM vs Lining diameter



Courtesy: Spgroup Singapore

- The first and foremost integration starts with the Diameter of the tunnel.
- The Tunnel diameter is driven by the functional requirements and independent of TBM and Lining.
- Finally the TBM is designed / Manufactured to suit the tunnel diameter.

Interface between TBM and Lining

Segment arrangement/ geometry

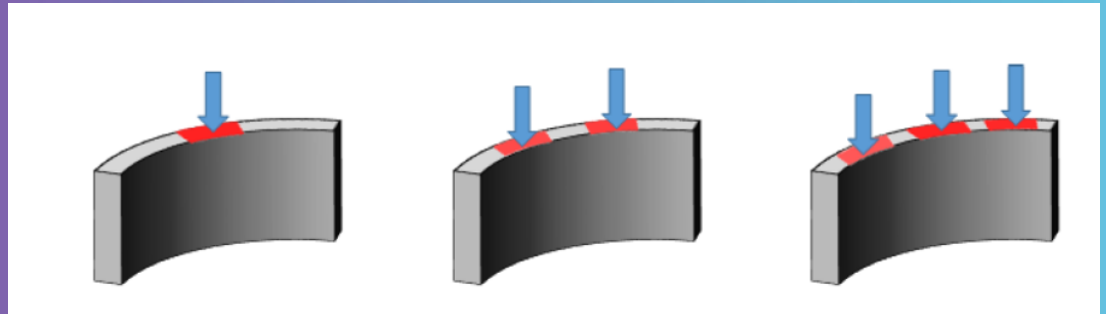
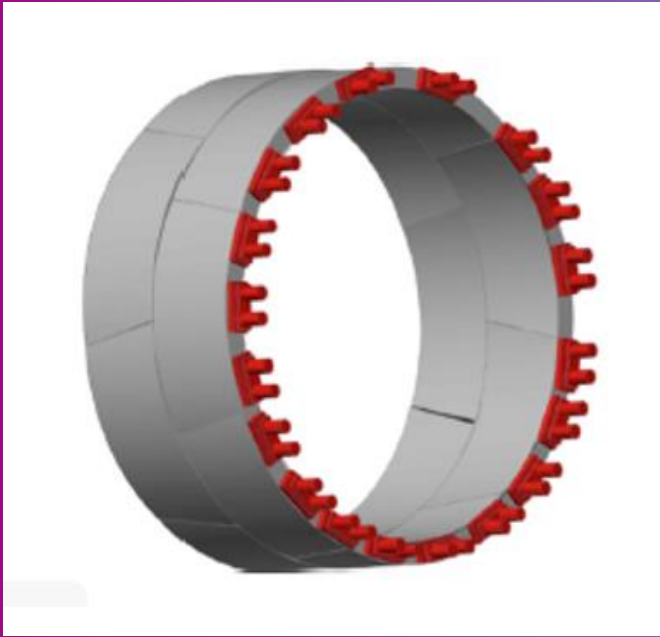
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TBM vs Lining / segment arrangement / segment geometry

- The lining usually consists of 5 to 7 segments to form a ring (Usually called as 5+1 or 6+1) – this pattern finally provides the tunnel diameter.
- The Number of Thrust Jacks and their distribution over the range of the ring is required for uniform stress distribution

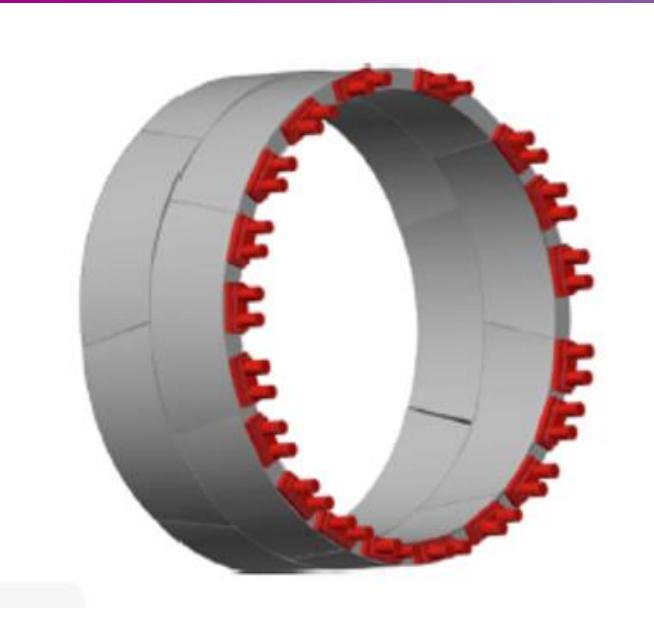
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TBM vs Lining / segment arrangement / segment geometry



Integration between TBM and Lining

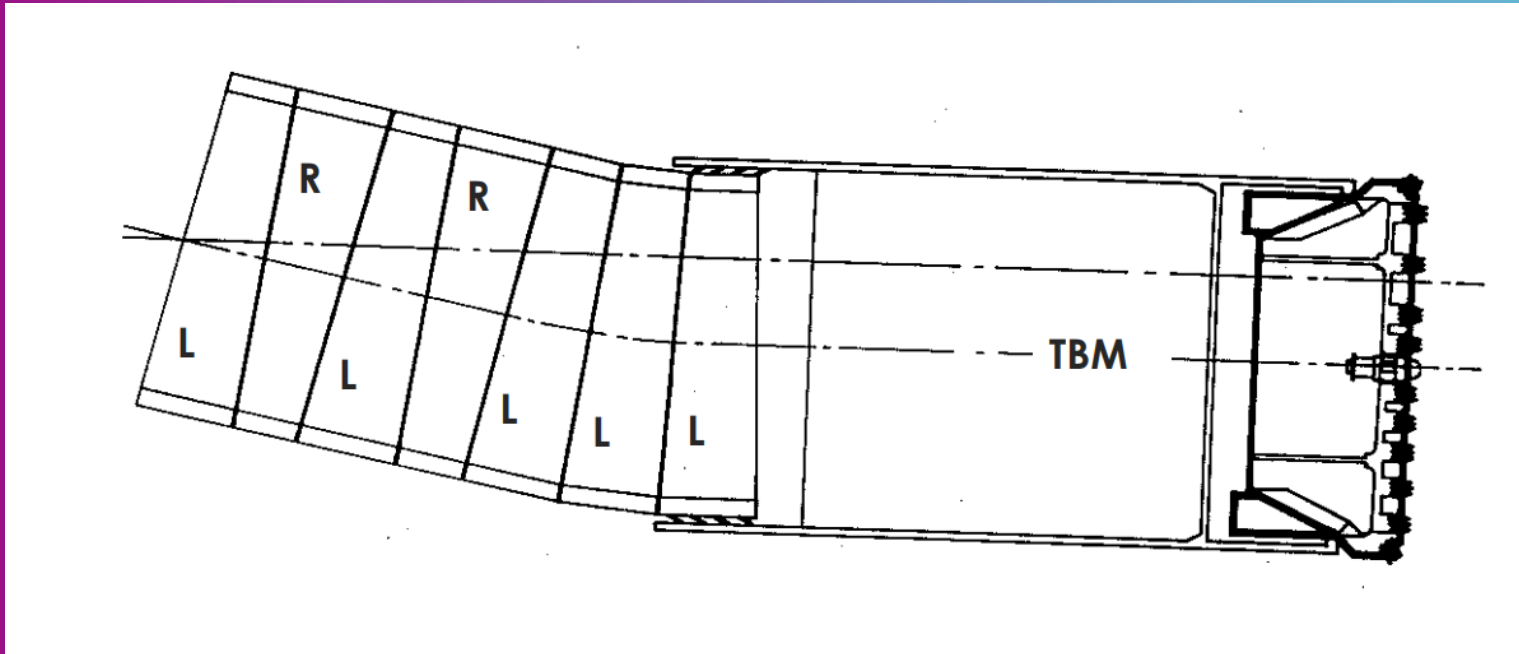
TBM vs Lining / Segment arrangement / segment geometry



Interface between TBM and Lining

TBM vs Lining / segment arrangement / segment geometry

- Segment Ring tapering : This is a function of tunnel curvature. A tighter tunnel curve requires more tapering which results in larger clearance between the segment and the tunnel shield.

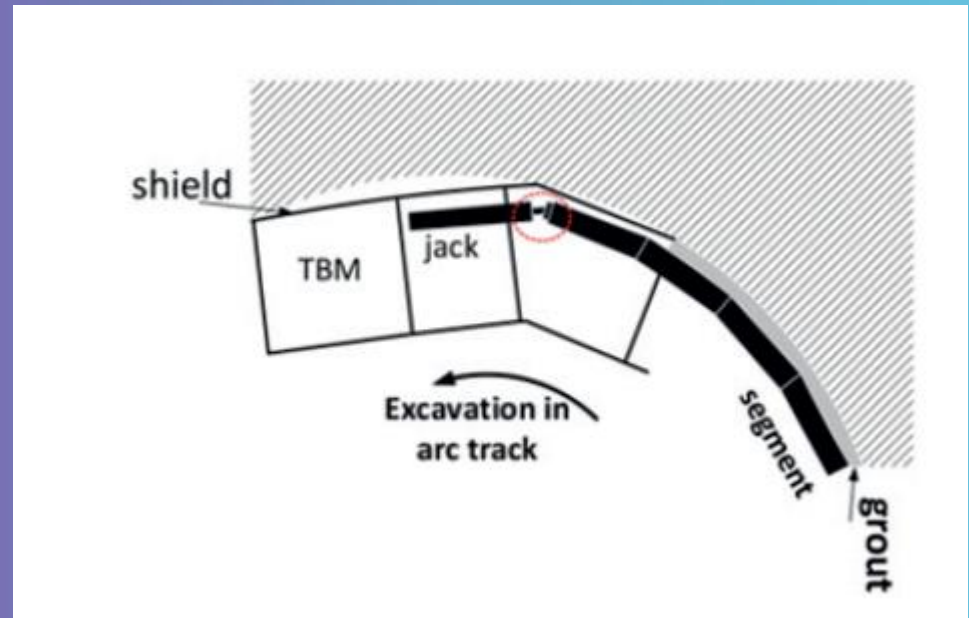
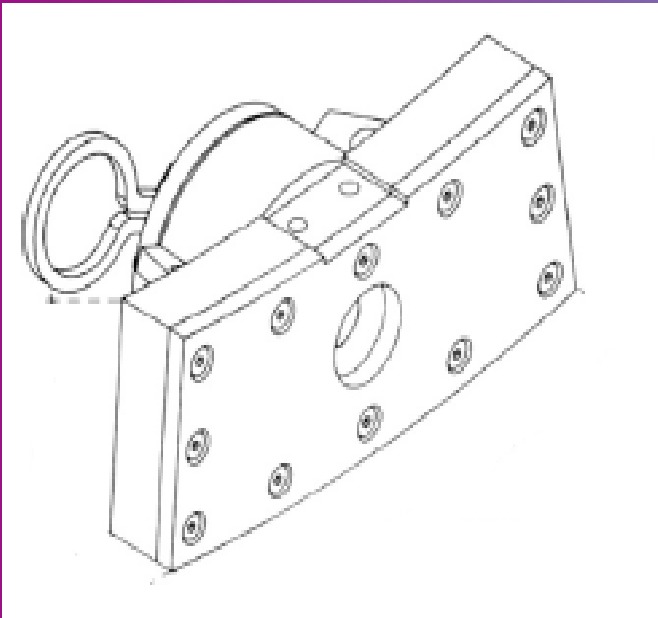


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Segment thickness/ height

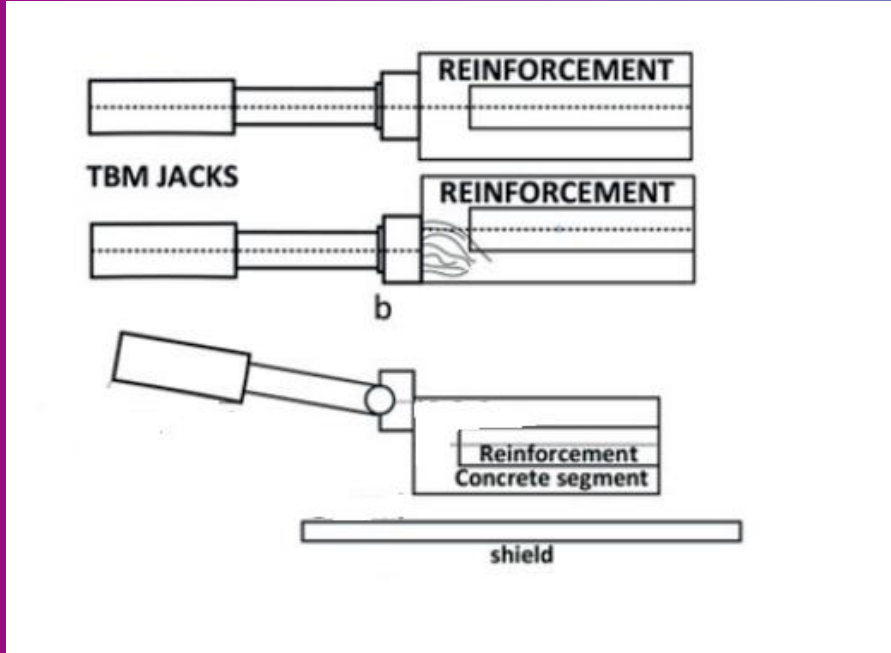
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TBM vs segment height (Thickness)



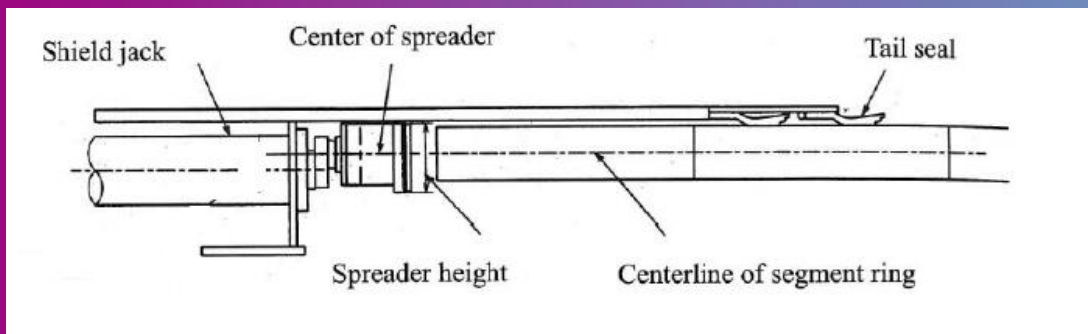
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TBM vs Segment Height (Thickness)

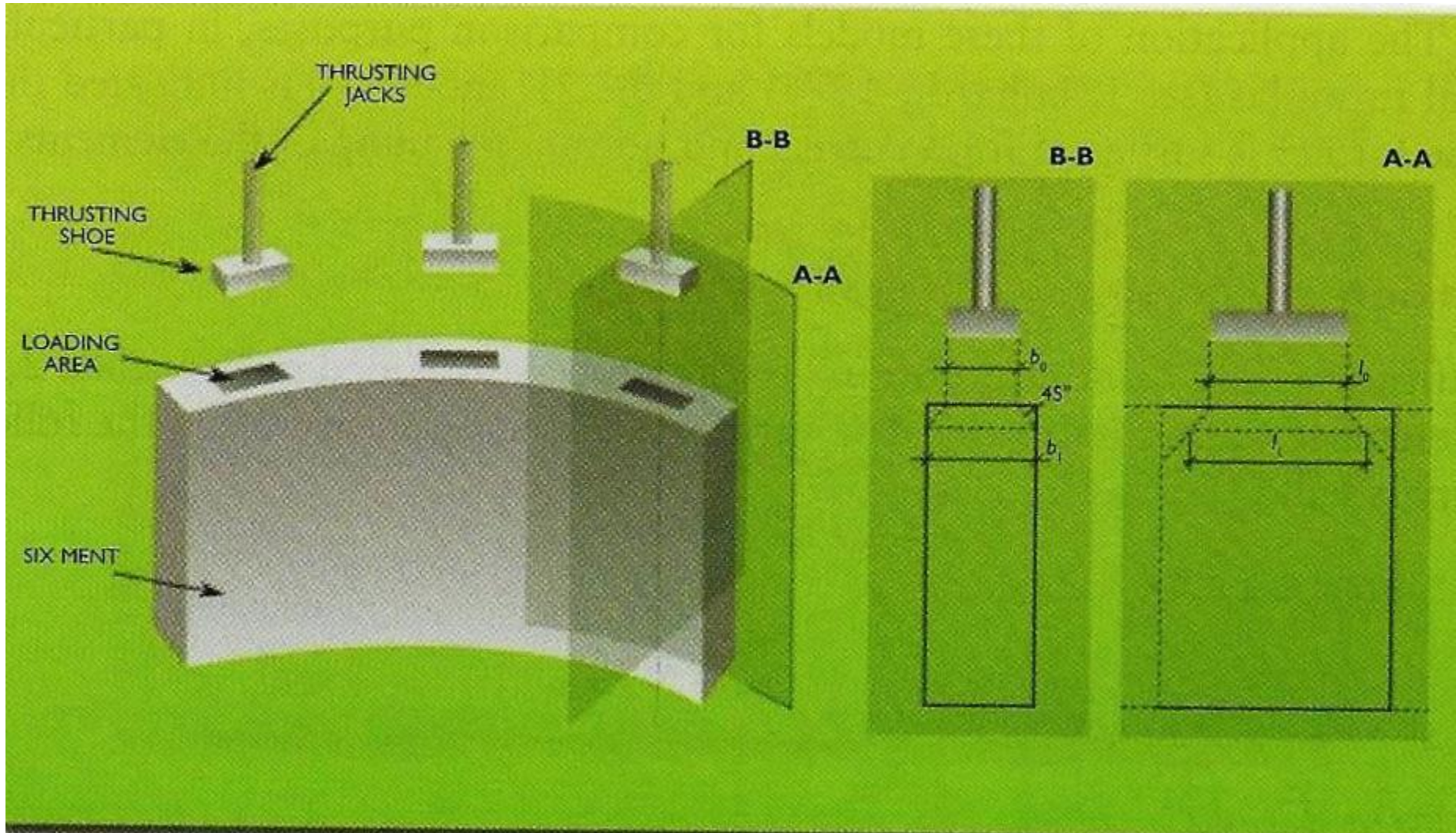


A study titled as "Statistical and Numerical study of chipping and cracking in Segmental lining" Mohammad Mohtadinal ,Mohammad Hossein Ahmadi,Milad Manafi Fasaghandis,Behnaz Dibavar and Seyed Morteza from different universities in Tehran

Concurrent segment lining and TBM design: A coordinated Approach for Tunnel success - E.Comis ,M. Younis & R. Goodfellow



Interface between TBM and Lining



Interface between TBM and Lining

Segment width / key

Interface between TBM and Lining

TBM vs segment width and key

- The segment width is measured in the direction of the tunnel axis.
- A narrow “Segment Width “ result in ease of transportation and erection, construction of curved sections, and reduction of shield Body length.
- A “Larger segment width” results in reduction of overall production costs of segments, number of joints and number of bolt holes.

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TBM vs segment width and key

The segment width in fact can be directly related to several aspects of TBM Interface



Interface between TBM and Lining

TBM vs segment width and key

- 1) Thrust Cylinders :The segment width regulates the main thrust cylinders stroke for one boring cycle. The stroke should match the segment width plus a preset margin.

Example :

For 1500 mm segment width - the Thrust cylinder should be $1500(\text{boring stroke} + 200 \text{ (Assumed margin)}) = \underline{1700 \text{ mm}}$

For 1200 mm segment with – The thrust cylinder should be $1200 \text{ mm}(\text{boring stroke}) + 200 \text{ (Assumed margin)} = \underline{1400 \text{ mm}}$

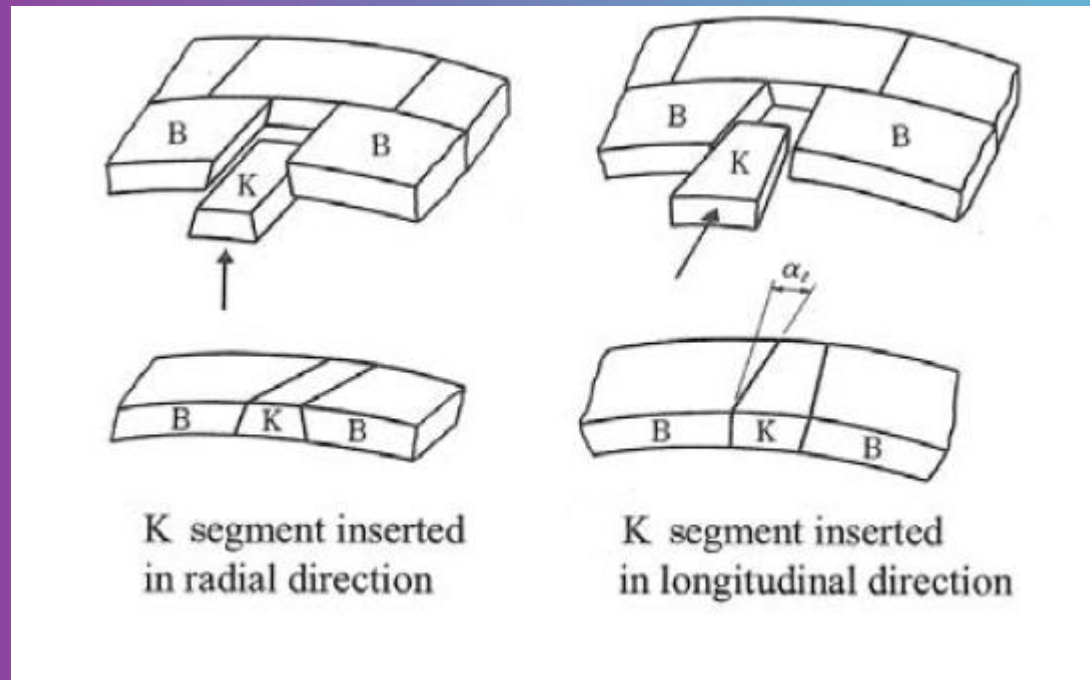
The change in length of thrust cylinder directly impacts the body length.

The longer the stroke of the jacks ,the bigger the rod diameter consequently bigger and expensive cylinder.

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TBM vs segment width and key

1) Thrust Cylinders .:



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TBM Design vs Segment width and Key

- 2) Shield body: The segment width regulates the overall shield body, irrespective of the TBM types

Example :

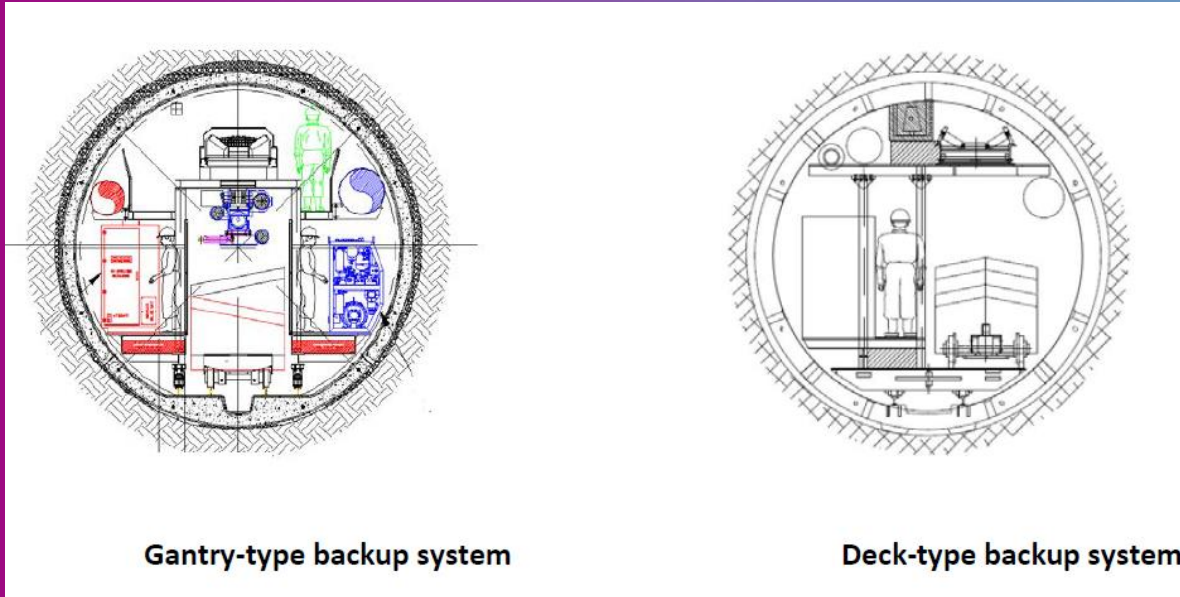
For 1500 mm segment width - The Tail shield should also be of higher 1500

For 1200 mm segment with – The thrust cylinder should be 1200 mm + 200 (Assumed margin) = 1400 mm

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TBM Design vs Segment width and Key

3) Back up layout : Segments are brought into the TBM through loco flat bed wagons longitudinally oriented: The segment width regulates the type of back up system



Interface between TBM and Lining

Division of segmental Ring

Interface between TBM and Lining

TBM vs Division of segment Ring

- For a given diameter the Number of segments constituting the ring effects the designn of major components such as the segment hoist and the segment erector.

The segment hoist is used to transfer the segments from the car to the ring build area

The segment erector is used to assemble segments into the tail shield.

The Number of segments per ring controls the quantity of handling operations

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Segment weight

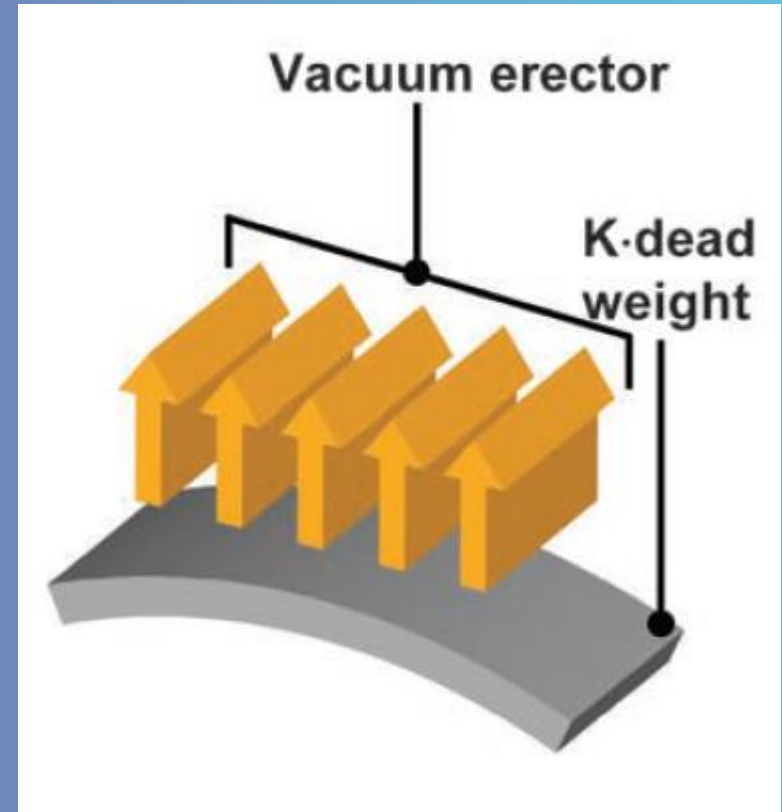
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TBM vs Weight of the ring

- The weight of the segment will enable the TBM vendor to design the segment erector and segment transporter accordingly.
- The design of type of erector Viz, Vacuum based or Pin based

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TBM vs Weight of the Segment



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TBM vs Weight of the Segment

